SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*REFORM IN MEDICAL EDUCATION.**

THE choice of a physiologist as the presiding officer of the Society of American Naturalists might, perhaps, have justified me in selecting some of the problems connected with experimental physiology as the subject of my remarks this evening, but, as questions of this sort are wont to awaken but a languid interest except among those who are themselves engaged in physiological research, I have thought it better to allow my choice of a subject to be guided by the fact that we are nearly all of us actively engaged in *teaching* as well as in *studying* our sciences, and to address you this evening upon some topic connected with education.

My own experience of 27 years as a professor of physiology and of 10 years as Dean of the Harvard Medical Faculty naturally inclines me to discourse upon the subject of medical education and, since the great profession of medicine demands from its practitioners a certain familiarity with the fundamental truths of all the natural sciences, it can surely not be inappropriate to ask the representatives of those sciences to consider with me how far the progress of medicine and of the allied sciences has made it desirable to revise our methods of imparting medical instruction.

*Address of the President, delivered before the American Society of Naturalists at the New York meeting, December, 1898.

Let me say at the outset that in speaking of the profession of medicine I use the term not in its narrow sense, to designate the art of curing disease, but in its broader signification, to include a study of the whole environment of man as far as it affects the production and maintenance of a healthy mind in a healthy body.

In what I shall have to say on this subject I shall confine myself chiefly to the medical schools of this country, though it will be found, I think, that the conclusions to which I shall endeavor to lead you will have their application to medical schools through the world.

The most important event in the history of medical education in this country occurred some thirty years ago, when many of the principal schools abandoned the plan of giving a series of winter lectures, which were attended by all the students, irrespective of their proficiency, and established a graded system of instruction in which the studies of one year were preparatory to those of the next. Those whose experience in medical education is confined to the period since this change was made can scarcely appreciate the value and importance of the reform which raised the medical schools of the country from a condition in which they were aptly compared to joint-stock manufacturing companies, concerned only in taking in as large an amount as possible of raw material in the shape of medical students and in turning out a maximum of the finished product, *i. e.*, doctors of medicine, with a minimum cost to the producer. 'Cheap doctors and plenty of them' seems to have been the motto of the medical schools of that period. Since this reform the medical schools of the country have been conducted on sound educational principles and the best of them compare favorably with the medical schools of Europe.

During the last quarter of a century the improvement in medical education in this country has consisted chiefly in increasing the requirements for admission, in the lengthening of the course and in the extension of the laboratory method of instruction. Important as these improvements have been, it may fairly be asked whether they have kept pace with the requirements imposed upon teachers by the remarkable advance in every department of medicine during the last thirty years.

During this period we have seen the germ theory of disease established upon a firm basis and extended so as to throw light upon a large number of morbid processes with which it was formerly supposed to have no connection. Antiseptic methods have revolutionized the surgeon's art. The study of the internal secretion of glands has led to the development of a system of glandular therapeutics. The use of the antitoxin treatment has robbed one, at least, of the most dreaded diseases of more than half of its terror, while the use of instruments of precision has increased the accuracy of our diagnosis in nearly all the ills to which flesh is heir.

At the beginning of this period it was possible to impart to an intelligent medical student in a three years' course of study a considerable fraction of the acquired medical knowledge of the time and to train him to safely use the comparatively simple methods of diagnosis and treatment then in vogue. At the present time, were we to seek to give to the same student a similar proportion of the accumulated knowledge now at the disposal of the profession and to teach him the use of the refined modern methods for the study and cure of disease, it may be reasonably estimated that a ten or even a fifteen years' course of study would be required. As it is obviously impossible to prolong the course of medical study to anything like this extent, the question arises: In what way shall newly ac-

quired knowledge in the science and practice of medicine be incorporated into the existing curriculum of the medical student?

Up to the present time this question does not seem to have been seriously considered. As new and important subjects have forced themselves upon the attention of the medical profession, our schools have sought to meet the new condition simply by adding to the existing curriculum a more or less lengthy course of instruction on the subject in question. Thus the importance of enabling physicians to recognize pathogenic microbes has led to the establishment of a department of bacteriology in our principal medical schools, while the great advance made in the treatment of special classes of disease has occasioned the appointment of numerous professors of specialties, such as gynæcology, orthœpedic surgery, pædiatrics, etc.

The medical curriculum has thus grown by what may be called, in biological language, a process of accretion, and there has been little or no attempt to make room for new instruction by the omission of less valuable courses or parts of courses, though in certain directions the advance of knowledge, by demonstrating the inaccuracy of previously accepted views, has led to a simplification of instruction. When it has been found absolutely impossible to add any further courses a remedy for the congestion of instruction has been found in the prolongation of the medical curriculum from three years to four.

It is, of course, evident that this process cannot be indefinitely continued. In fact, a slight study of the subject suffices to show that a limit has already been reached. Indeed, as long ago as 1870 Huxley was so thoroughly impressed with the crowded condition of the medical curriculum in England that he expressed "a very strong conviction that any one who adds to medical education one iota or one tittle beyond what is absolutely necessary is guilty of a very grave offence,"* and quite recently Professor M. Foster, in speaking of the enormously increased requirements in medical education, has expressed himself as follows: "Now it is obvious that, whatever may have been possible once, it is impossible nowadays to demand that all or each of these things should be learnt by the student of medicine. Though possibly the power of man to learn is increasing; though each science as it becomes more and more consolidated can be expounded and apprehended with greater ease; though the grasping of one science is in itself a help to the grasp of other sciences, yet beyond doubt that which has to be learnt is enlarging far more rapidly than is man's ability to learn."†

To extend the course of instruction in the medical schools of this country beyond the present four-year limit does not, under the prevailing conditions of education in America, seem desirable, and the curriculum of most of our schools is already so crowded that no considerable amount of instruction can possibly be added. In what way, then, can we give to our medical students an adequate amount of information on all the subjects embraced in the constantly widening domain of medical science and art? In other words, how shall instruction keep pace with knowledge?

In seeking an answer to this question it may be assumed that a medical school of the first rank should be an institution in which the most advanced instruction in all departments of medicine can be obtained, and on this assumption it is, of course, impossible to arrange a course of study that every student *must* follow in all its details, for in the time which may properly be de-

* 'Medical Education.' Collected Essays, Vol. III., D. Appleton & Co., 1894.

† Address to the Students of Mason University College, Birmingham, October 3, 1898.

voted to a course of professional study it is quite impossible for even the most intelligent students to assimilate all the varied information which such a school may reasonably be expected to impart.

It seems, therefore, to be evident that in arranging a course of medical study a distinction must be made between those subjects which it is *essential* that *every* student should know, and those subjects which it is *desirable* that *certain* students should know, *i. e.*, between those things of which no man who calls himself a physician can afford to be ignorant, and those which are important for certain physicians but not for all. In other words, provision must be made both for required and for *elective* studies.

The introduction of the elective system into a professional school is not an altogether novel proposition. For several years a large part of the instruction in the fourth year of the Harvard Medical School has been given in elective courses in various specialties, such as ophthalmology, otology, etc. The extension of the elective system to the earlier years of the course would be attended by no difficulty as far as details of administration are concerned, and has, indeed, been advocated by President Eliot in a speech at the dinner of the Harvard Medical Alumni Association in 1895. But the question may, perhaps, be asked whether it will be possible under such a system to secure the proper training of young men for the duties of a profession in which experience of life contributes so largely to success, and in which, therefore, a student at the beginning of his career may be supposed to be peculiarly in need of the guidance of his teachers.

It is true that in the academic department of Harvard University the capacity of the average student to choose his course wisely and well has been demonstrated by the experience of many years, but it may be properly urged that the success of the system in the academic department does not necessarily justify its extension to a professional school. The responsibility of the medical faculty in granting the degree of M.D. is very different from that of the academic faculty in giving the A.B. diploma, since an imperfectly qualified practitioner of medicine may endanger the lives of his patients, while an unworthy graduate of the academic department can, as a rule, injure no one but himself. Hence the medical faculty may justly be required to exercise greater caution in bestowing the degree of M.D. than is necessary in the case of the A.B diploma. We must, therefore, enquire whether it is possible to obtain the advantages of a flexible curriculum consisting largely of elective courses without losing the security against superficial and imperfect work which the present compulsory system is supposed to afford.

Any one who is familiar with the existing methods of medical instruction is aware that in nearly every department many things are taught which are subsequently found to be of use to only a fraction of those receiving the instruction. Thus the surgical anatomy of hernia is taught to men who will subsequently devote themselves to dermatology; future obstetricians are required to master the details of physiological optics, and the microscopical anatomy of tumors forms a part of the instruction of men destined to a career as alienists. Now, no one can question the propriety of including instruction on all these subjects in the curriculum of a medical school, but it may be questioned whether *every* student should be forced to take instruction in them *all*. It may, perhaps, be urged that no choice of studies can be made without determining, to some extent, the direction in which the work of the future practitioner is to be specialized, and that such specialization cannot be properly and safely permitted until the student has completed his medical

studies. To this it may be answered that, whatever may be the dangers of too early specialization, the dangers of crowding the medical course with instruction of which many students do not feel the need and of thus encouraging perfunctory and superficial work are certainly no less serious. Moreover, it will, doubtless, be found perfectly possible to establish such a relation between the required and the elective courses that the requirements in each department will be in no way lowered, while a certain freedom of choice is permitted with regard to the direction in which the work is pursued. To illustrate this point, allow me to describe a possible arrangement of a course of study in the department of physiology with which I am, of course, more familiar than with any other.

In the Harvard Medical School instruction in physiology is now given in a course of about 100 lectures, besides recitations, conferences and practical laboratory work. Were the work to be rearranged in accordance with the above plan it would probably be found possible to condense into a course of about 50 or 60 lectures all the most important facts of physiology with which every educated physician must necessarily be familiar. Attendance upon these lectures, combined with a suitable course of text-book instruction, would suffice to guard against gross ignorance of physiological principles. In addition to this required work, short courses of eight or ten lectures should be provided, giving advanced instruction in such subjects as the physiology of the special senses, cerebral localization, nerve-muscle physiology, the internal secretion of glands, the physiology of the heart, circulation and respiration, the digestive secretions, the reproductive organs, etc. These courses should be elective in the sense that no student should be required to take them all. Each student might, however, very properly be required to choose a certain number of courses, which, when once chosen, become, for him required courses leading to examinations. The number of special courses which each student should be thus required to elect should be sufficiently great to render the total amount of physiological instruction in no way inferior to that which is given under the present system.

It would, doubtless, be found desirable in practice not to confine the possibility of taking elective courses to the year in which the required instruction is given, for a student may frequently, in the latter part of his course, become interested in a subject like mental diseases, for instance, and will then be glad of an opportunity to take special instruction on the physiology of cerebral localization. The elective courses should, therefore, be so arranged that they may be taken in any part of the medical curriculum.

There is, in my opinion, no doubt that an arrangement of instruction similar to that here suggested for physiology could be advantageously adopted in the departments of anatomy, histology, bacteriology, medical chemistry, pathology, surgery, and in the courses of instruction in the various special diseases, such as dermatology, opthalmology, etc. Whether the instruction in clinical medicine and clinical surgery can be thus modified is a question about which more doubt may be entertained and which I prefer to leave to persons of greater experience than myself in methods of clinical instruction.

Under the existing conditions of medical education the introduction of the elective system in some form or other seems to be an essential condition to any further important advance. If it be said that under this system the medical degree will cease to have the definite meaning now attached to it, and that it will be impossible to tell from his

diploma in what way a physician has been educated, it may be replied that, though the degrees of A.B., A.M., Ph.D. and S.D. are affected with exactly this same uncertainty of signification, their value seems in no way diminished thereby. As long as the M.D. degree stands for a definite amount of serious work on medical subjects directed on the lines above indicated we may be reasonably sure that those who hold it will be safe custodians of the health of the community in which they practice.

If it be urged that the elective system in medical education will lead to the production of a class of physicians who, owing to the early specialization of their work, will be inclined to overrate the importance of their specialty and to see in every disease an opportunity for the display of their special skill, it may be pointed out that this result is apt to be due not so much to early as to imperfect instruction in the work of a specialist, and that, since the elective system tends to encourage thoroughness in special instruction, the evil may be expected to diminish rather than to increase.

I have spoken of the extension of laboratory instruction as an important forward step in the improvement of educational methods in medicine during the last quarter of a century, and I desire to bring my remarks to a close with a few words on the relation between laboratory and didactic methods in medicine and on the employment of both methods in a system of instruction including both required and elective courses.

There is perhaps no field of human activity in which the pendulum of reform makes wider excursions than in that of education. Whenever any given method is found to give unsatisfactory results there is a strong tendency to abandon it altogether in favor of some entirely different method. Thus the obvious defects of the oral system of examination employed in the Harvard Medical School thirty years ago led to its complete abandonment and to the adoption of the written examination book, though there is little doubt that a system combining the advantages of both the oral and the written methods could easily have been devised. In the same way the fact that many subjects have been, and indeed still are, taught in systematic didactic lectures which can be better taught by laboratory methods tends to obscure the equally important fact that there are many other subjects in the presentation of which the living personality of the lecturer is a very important factor and which, indeed, can be properly presented to students only by those who have had much experience in weighing scientific evidence. In this connection it is interesting to recall the wise words of Huxley, who expressed himself on this subject as follows: "What the student wants in a professor is a man who shall stand between him and the infinite diversity and variety of human knowledge, and who shall gather all that together and extract from it that which is capable of being assimilated by the mind."*

To what extent the laboratory can replace the lecture room will, of course, depend upon the nature of the subject taught. In such a branch as Anatomy, where facts learned by observation form the greater part of the knowledge to be imparted, laboratory work can be substituted for didactic instruction to a greater extent than is possible in subjects like Physiology and Pathology, where inferences from observations and conflicting views must frequently be presented. In no department of medicine, however, will it probably be found possible to dispense entirely with a systematic course of lectures in which a trained instructor may give to his class the benefit of his accumulated experience.

*l. c.

A consideration of the nature of the subject taught will also furnish a guide for the employment of laboratory and didactic methods in the required and elective courses above suggested. In general the required courses, being comparatively elementary and concerned chiefly with the presentation of well ascertained facts, may be made demonstrative in their character and may be conducted in accordance with laboratory methods, though a short course of didactic lectures, parallel with laboratory work, will in most cases be found to be essential. In the elective courses which provide advanced instruction in many directions the limits of our knowledge will be more nearly reached. It will, therefore, be necessary to present and weigh the evidence for and against the various conflicting views which are almost certain to be held with regard to subjects lying within what Foster has called the 'penumbra' of solid scientific acquisition. For this purpose the most suitable method of instruction seems to be a short course of carefully prepared didactic lectures which should, however, be varied by demonstrations whenever the nature of the subject will allow.

It is, however, unnecessary to discuss these and other details at the present time. They will speedily arrange themselves as soon as the necessity for a comprehensive reform in our methods of medical instruction is generally recognized, and it is in the hope of helping to secure this recognition that I have addressed these remarks to you this evening. In whatever way the remedy is to come it should not be long delayed, for the difficulty of giving adequate instruction to constantly increasing classes seeking information over a constantly widening field of knowledge is felt each year with greater and greater keenness.

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*ON THE INCREASING IMPORTANCE OF INORGANIC CHEMISTRY.**

WHENEVER a paper by Van't Hoff appears, it is read by chemists and especially by physical chemists, with unusual interest. This is due to the fact that the comparatively few papers which he has published have had such a marked influence on scientific thought, and on the development of those branches of knowledge to which he has devoted his energies.

The present lecture is probably the result of his observation, since he has been in Berlin, that by far the larger number of German chemists are devoting themselves to organic chemistry. At the same time that he recognizes the importance of this field of investigation, he utilizes this opportunity to call attention to the difference between the two branches of chemistry, organic and inorganic, and to point out some of the advances which have been made, especially in the latter. The main points of his lecture will be given partly in his own language, and partly as a free account of what was said.

The distinction between organic and inorganic compounds dates back some two hundred years. Those occurring in organic nature, in living things, were called organic, while those existing in the mineral kingdom were called inorganic. This division had, at the outset, a certain scientific justification, since inorganic chemistry had to deal with the comparatively simple problem of explaining the chemical transformations in dead matter, while organic chemistry dealt with the much more complex problem of the processes in living organisms.

While the original definitions of the two branches have changed somewhat as new facts have been discovered, yet this essential

* Lecture before the 70th meeting of the Society of German Scientists and Physicians in Düsseldorf. —*Ztschr. f. Anorganische Chemie*, 18, 1.